THE FACET JOINTS: ANOTHER LOOK*

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THE clinician's attack on the problems of low-back pain and sciatica as yet has been only partially successful. In large measure this failure may stem from incomplete understanding of the posterior articulations of the spine—the facet joints.

In the earlier part of this century the facet joints were the focus of intensive research and speculation with regard to their role in the production of back pain and sciatica. After Mixter and Barr in 1934 implicated the herniated disk in sciatica, discussion and research channelled into the narrow and artificially separate concepts of "soft" disc disease versus spondylosis or "hard" disc disease. The posterior articulations of the spine have been neglected somewhat. In the last 20 years, however, it has again become apparent that the posterior elements of the spine play a vital role in the pathogenesis of both low-back pain and sciatica. We would like to redirect attention to some aspects of the dorsal articulations and the development of disease in this region. We also would like to discuss some current surgical thinking about this part of the spine. But we would add this caveat: pathologic changes in the posterior articulations of the spine must be viewed within the larger concept of degenerative disease of the entire lumbar spine if the clinical approach to spinal disease is to be successful.

Therefore, we are presenting first a short discussion of the anatomy of this area, then some words about the pathology of the lumbar articulations and our surgical approaches, and finally a few thoughts about the future.

Each cartilaginous human vertebra develops three primary ossification centers: one for the body and one for each side of the neural

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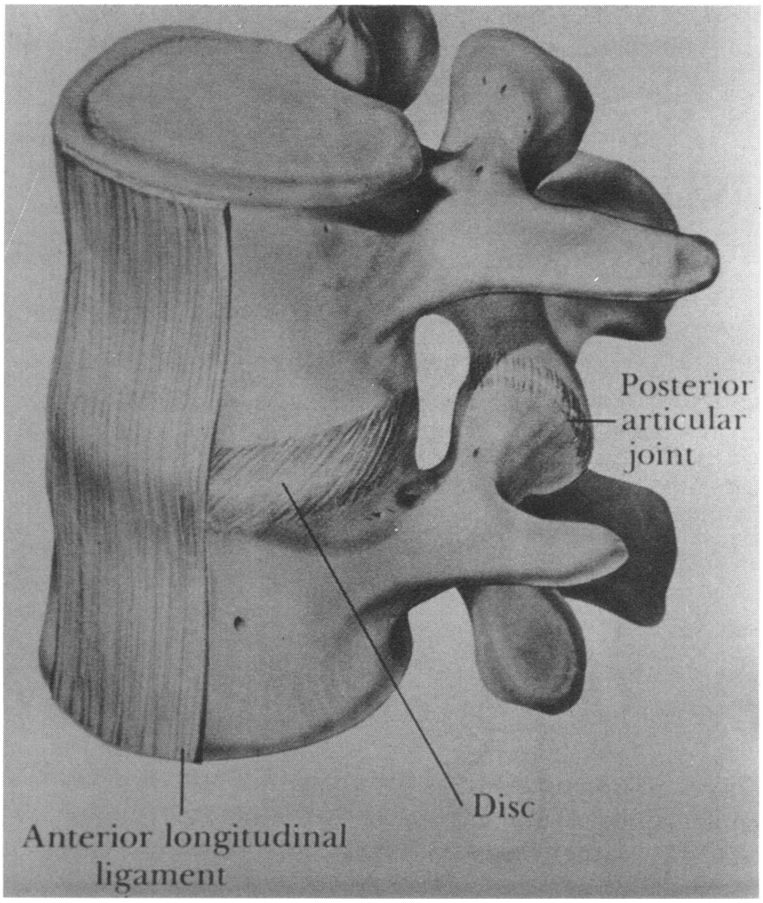

Fig. 1. The posterior articulating facet joint and its relation to the intervertebral foramen.

arch. In the lumbar spine the lamina unites at the midline in the first year of life and the arch joins the body at the sixth or seventh year of life. The apophyseal or articulating joints of the spine develop from the posterior arch.

The relation of the facet joint and the intervetebral foramina is vital to an understanding of spinal disease. The segmental nerve roots are the major contents of the intervertebral foramina. In addition, the foramen contains several blood vessels and a small nerve—the sinu-vertebral nerve of Luschka—which is of great importance in lumbar pain syndromes. The relations of the intervetebral foramen may be seen in Figure 1. Anteriorly, we find the vertebral bodies and the

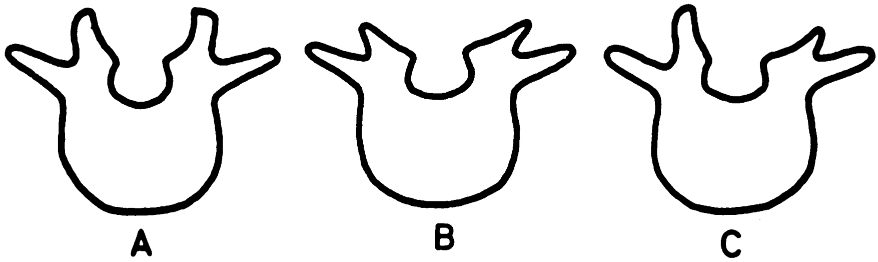

Fig. 2. Three types of orientation of the facets in the lumbar spine.

intervertebral disc; superiorly and inferiorly, the pedicles of adjacent vertebrae; and posteriorly, the superior and inferior articulating processes and the ligamentum flavum. As can be seen, the articular processes project from the junction of the pedicles and the lamina.

In an adult the intervertebral foramen has approximately five to six times the diameter of the nerve which courses through it. However, in both flexion and extension of the lumbar spine the available space decreases markedly, and it is the facets which cause this compromise of available space.

We wish to stress the following points: The dorsal articulations of the spine are true joints; they are lined with cartilage and synovial tissue and have a complete capsule. The orientation is such that the superior facets are concave and face both dorsally and medially; the inferior facets are convex and face ventrally and laterally. The inferior articulating surfaces are closer together and hence are embraced by the superior articulating surfaces.

Figure 2 is a representation of the inclination of the articulating surfaces of the facets; that inclination is about 45 degrees to a sagittal plane at the L1-L2 level as in A, and assumes an increasingly frontal orientation moving caudad; B represents the L5-S1 level. There is an asymmetry of orientation, as in C, in the facets of a significant number of normal spines. We shall discuss the implications of this fact in a later paragraph.

The main functions of the posterior articulating joints are to guide flexion and extension of the spine and to limit rotation of the spine. The latter is of great importance, since rotary stress is the most deleterious to the intervertebral disc. It is thought also that the joints of L4-L5 and L5-S1 prevent the anterodisplacement caused by the lumbar

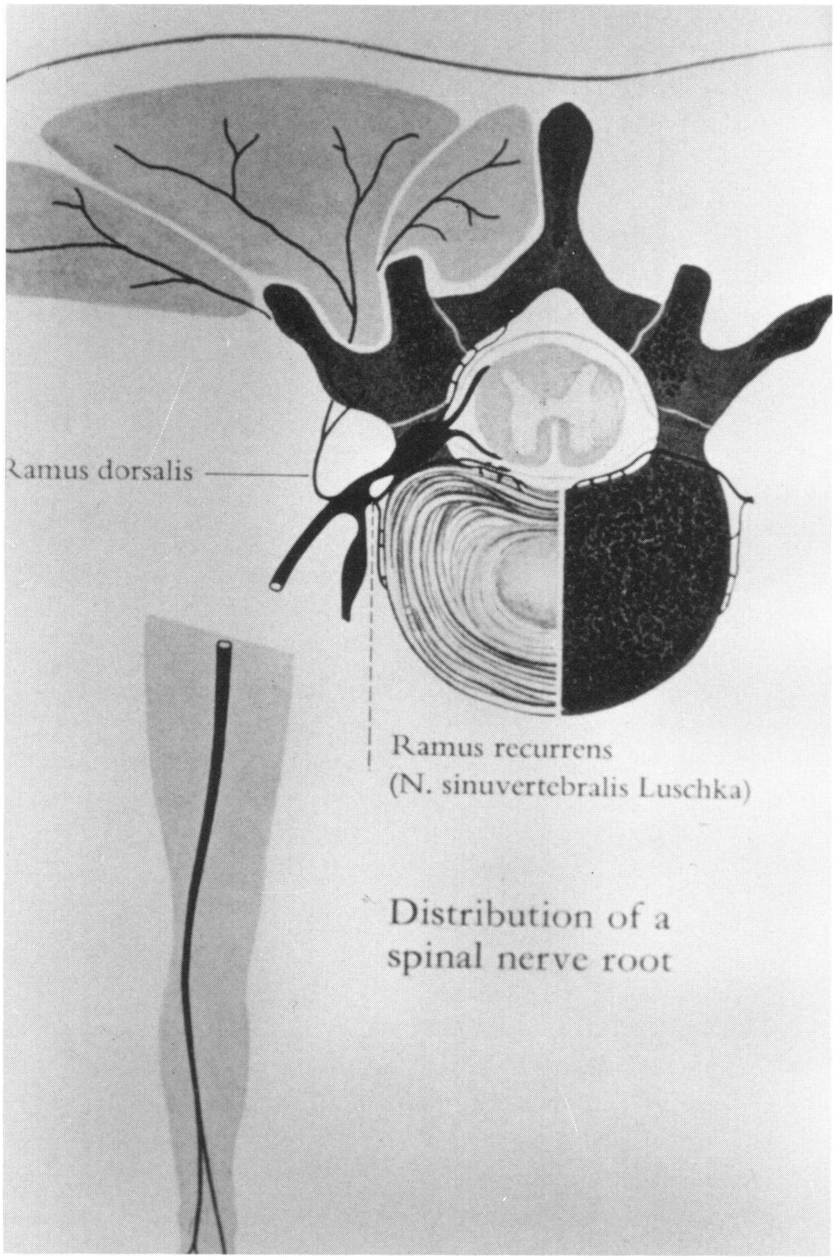

Fig. 3. Schematic representation of the spinal nerve, the dorsal ramus, and the sinuvertebral nerve of Luschka.

lordosis in the erect posture. The articular joints of the lumbar spine carry only a small fraction of the total load on the spine.

Two nerves are vital to an understanding of low-back pain and sciatica. The sinuvertebral nerve of Luschka is a recurrent branch of the spinal nerve, originating in the spinal canal at or near the rami communicantes. It gives off sensory fibers to bone, epidural blood vessels, the outer layers of the annulus fibrosus, the dura mater, and the posterior longitudinal ligament. This nerve has been implicated in pain syndromes related to the degeneration of discs.

More important to the present discussion is the posterior ramus of the nerve root. The take-off of this ramus is just distal to the sensory ganglion (see Figure 3). The ramus turns backward and passes inferiorly and dorsally between the transverse process and the facet joint, sending processes to the articular capsule. The main portion then continues inferiorly onto the inferior articulating process, finally ramifying in the dorsal spinal musculature (Figure 4). Inspection of this arrangement reveals that each articulating facet joint has bisegmental innervation. The posterior ramus contains both sympathetic and sensory fibers.

The capsule of the intervertebral joint has been found to have three kinds of putative pain receptor; it includes complex unencapsulated and small encapsulated endings as well as the more usual free-fiber endings.

Apophyseal Arthritis

Keeping these anatomical arrangements in mind, we should like to review certain aspects of the pathology of the lumbar facet joints. The first subject will be apophyseal arthritis.

Degenerative arthritis of the spinal joints is rare before 30 years of age; after the age of 45 osteoarthritis begins to appear more and more frequently and may be found in postmortem studies in more than 90% of lumbar spines after that age. The degeneration of discs is the dominant cause of spinal disease from age 20 to 45 years of age, but after that time combined degeneration is the rule. It appears that degeneration of the lumbar disc disposes to osteoarthritis of the facet joint, but it is not an invariable consequence. The arthritic lumbar joints, like joints of the extremities, exhibit a mixture of degenerative and restorative processes. Lesions of the joints and capsules

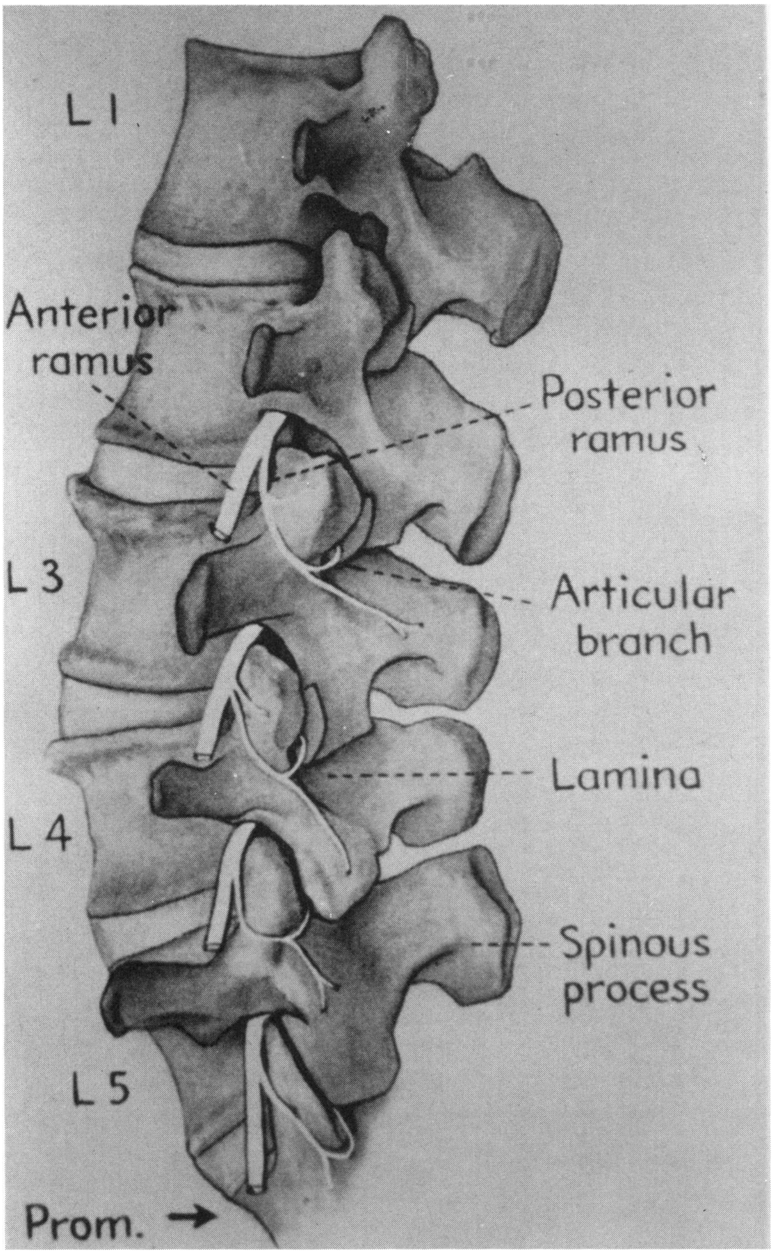

Fig. 4. The course of the posterior or dorsal ramus of the nerve. Reproduced by permission from Pederson, H., Bluncik, E., and Gardner, G.: The anatomy of lumbosacral posterior rami and meningeal branches of spinal nerves. *J. Bone Joint Surg. 38A:* 379, 1956.

include edema, granular ossification, calcification, and adhesions between the capsule of the facet and the meningeal covering of the adjacent nerve root. Remodeling and the formation of osteophytes are the most prominent features. Osteophytes in the lumbar spine have long been implicated as irritants to the spinal nerve roots as they course out through the intervertebral foramina. The importance of osteophytes and their prevalence has been well recognized by the surgeons; at the present time examination of the intervertebral foramina and foramenotomy or excision of the impinging facetal osteophytes is increasingly routine in lumbar surgery. A question which needs resolution is whether iatrogenic violation or denervation of the joint predisposes the patient to arthritis. Osteoarthritic changes in the lumbar joints are most frequent at the L4-L5 and L5-S1 levels. Why should this be so? Scandinavian workers have shown that these low segments, especially L4-L5, support the vertex of the lumbar lordosis and hence are subject to the greatest stress.

A number of unanswered questions with regard to arthritis of the facet joints have to do with the problem of asymmetry. Arthritis of the facets appears to be associated more commonly with asymmetry of the facets themselves. In a large autopsy study,[1] approximately 20% of superior sacral facets were asymmetrical by more than 10 degrees in relation to the sagittal plane. Other studies have yielded similar figures for the L3-L4 and L4-L5 facet joints. Most students of the lumbar spine conclude that asymmetry appears to be a functional adaptation to mechanical stress rather than a primary abnormality in the lumbar spine. A question to be resolved by future work is what effect asymmetry in the lumbar facets has on disc degeneration. We know that the more obliquely oriented a facet is, the less it can resist rotary stress. In an asymmetric situation, when one facet is oblique, rotation occurs toward that side. Farfan and others[2] have suggested that abnormal stress is placed on the posterolateral disc by such asymmetry; he has found a high correlation between asymmetry of facets, sciatica, myelographic defect, and disc protrusion found at operation.

With concomitant degenerative disc disease, deterioration of the facet joints can allow posterior slippage of the vertebra; this is due to the orientation of the facet joint. The retrodisplacement thus produced narrows the intervertebral foramen. This in turn traps the nerve root between the superior articular process and the pedicle above.

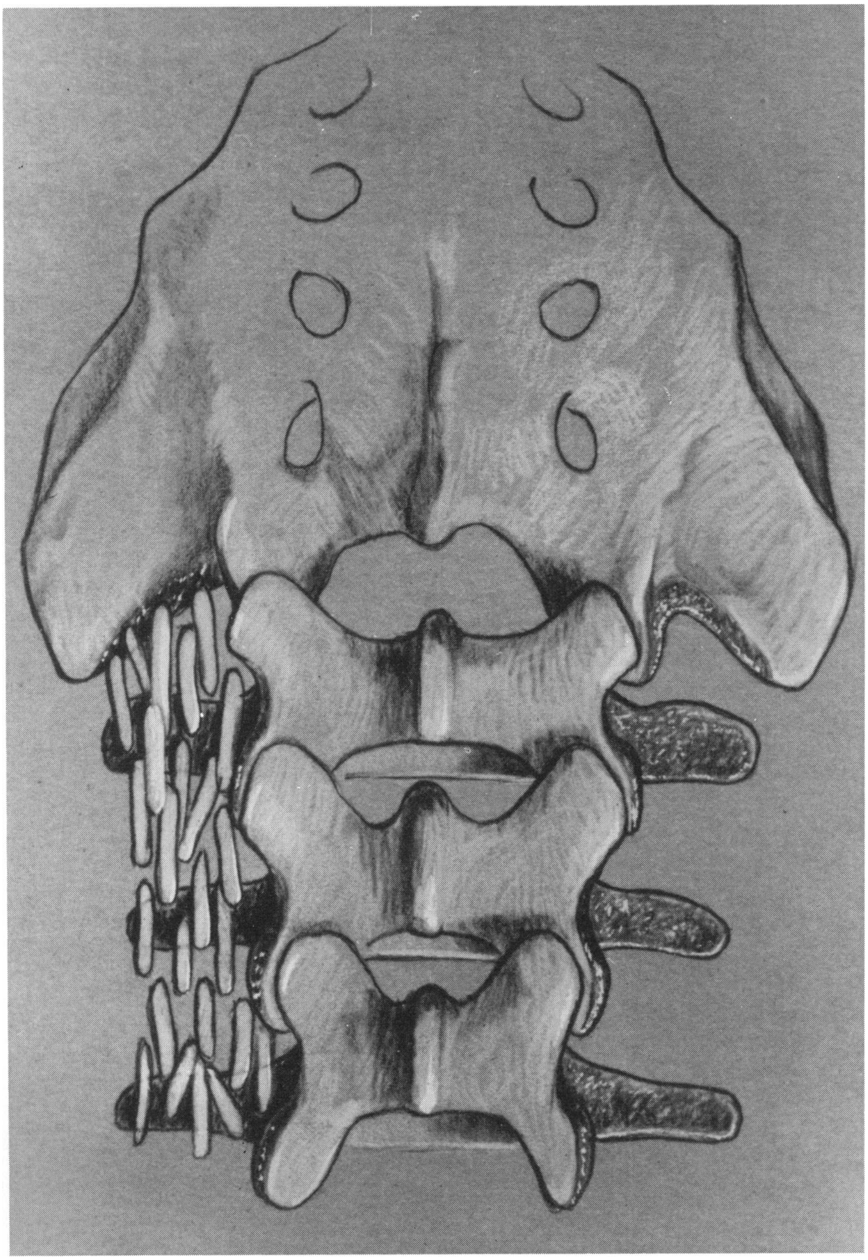

Fig. 5. The method of fusion. Note decortication, and hence probable denervation, between the transverse process and the facet.

Under certain circumstances, with destruction of a facet joint an anterior slippage of a vertebral body can occur. This is termed pseudo-spondylolisthesis. Again, a radicular syndrome and back pain may result from this condition.

It has been assumed over the years that arthritic changes in the facet joint cause pain in the back. We know that the nerve fibers exist. We know that injection of Xylocaine into the joint eases some back pain. We know that fusion eliminates movement and therefore may eliminate pain. We know that there is a higher incidence of back pain in situations of excessive stress on a joint, as, for instance, in hemisacralization of the fifth lumbar vertebra. But why should there be radiating leg pain? A number of studies have shown that painful stimuli in the dorsal structures of the spine—in the area innervated by the dorsal ramus—can cause referred pain in the leg, in a region innervated by the anterior ramus. A variety of surgical approaches to pain originating in the dorsal articulations have stemmed from combined clinical and research observations. The procedure of steroid injection is controversial but has theoretical and clinical justification. We might also explain the success of spinal fusion in the elimination of pain—long before any bony solidarity can take place—as follows (Figure 5): In our present successful method of lateral fusion, great technical care is taken to curette thoroughly the area between the superior facet and the transverse process; this no doubt destroys the dorsal ramus of the nerve and denervates the facet joint. Thinking along these lines has led some surgeons to attempt a new procedure for the relief of pain—dorsal rhizolysis, also termed facet rhizotomy.

Rees in 1971[3] and then Toakley and others in Australia[4] described a procedure involving the percutaneous sectioning of the dorsal ramus. The procedure could be performed under fluoroscopy and involved minimal risk; the published results were astounding. In 200 patients with unremitting back pain, 152 of whom had radiating pain as well, Toakley described 125 good and 37 fair results with a follow-up of six months to two years.[4] Shealy and others[5] have developed electrocoagulation rhizolysis. This also is performed easily under x-ray control; an insulated needle is placed carefully in the area of the dorsal ramus, through a cutaneous wheal raised with Xylocaine. A radio-frequency generator is then used to cause a coagulative lesion; because of the bisegmental innervation of the facet joints it is necessary to treat two

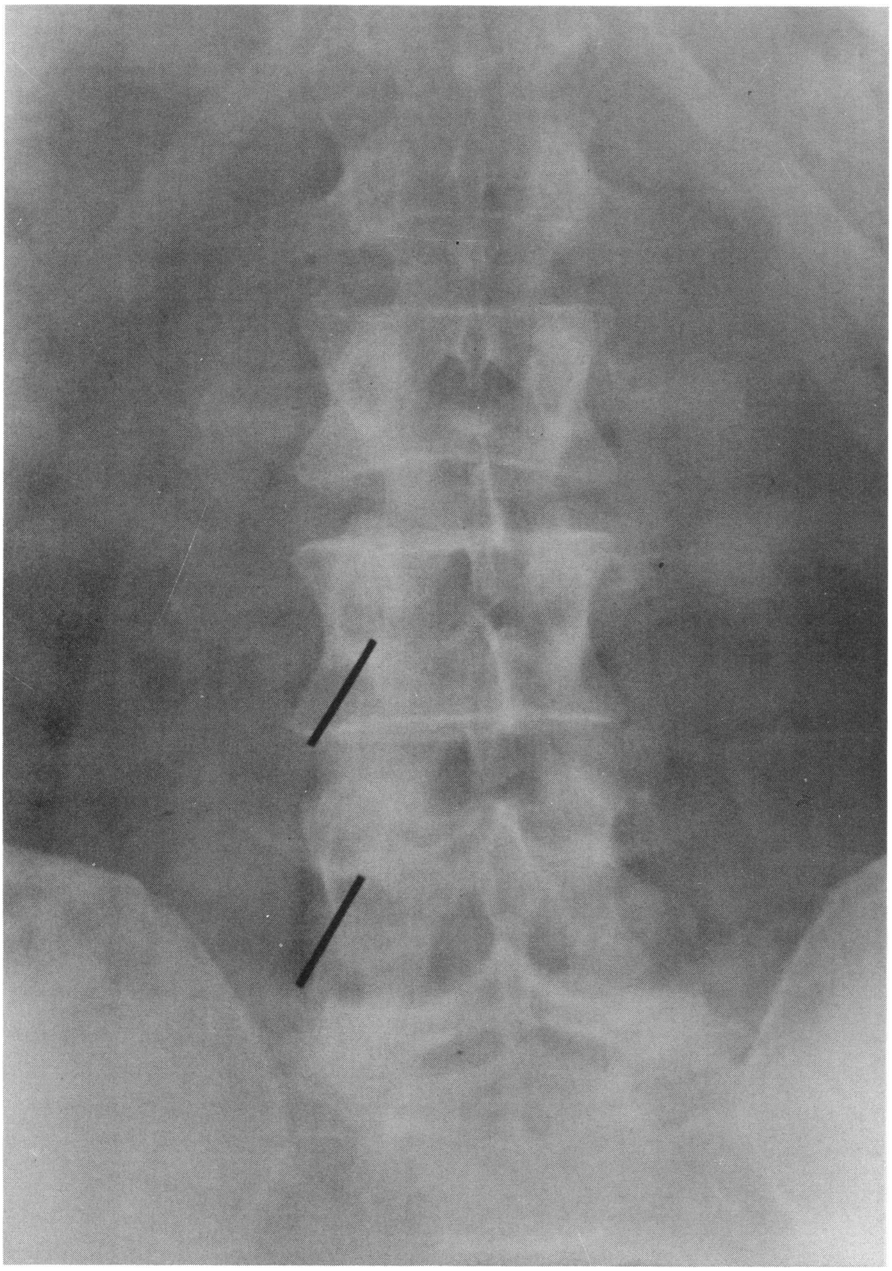

Fig. 6. Positioning of facet rhizotomy needles, anterior-posterior view.

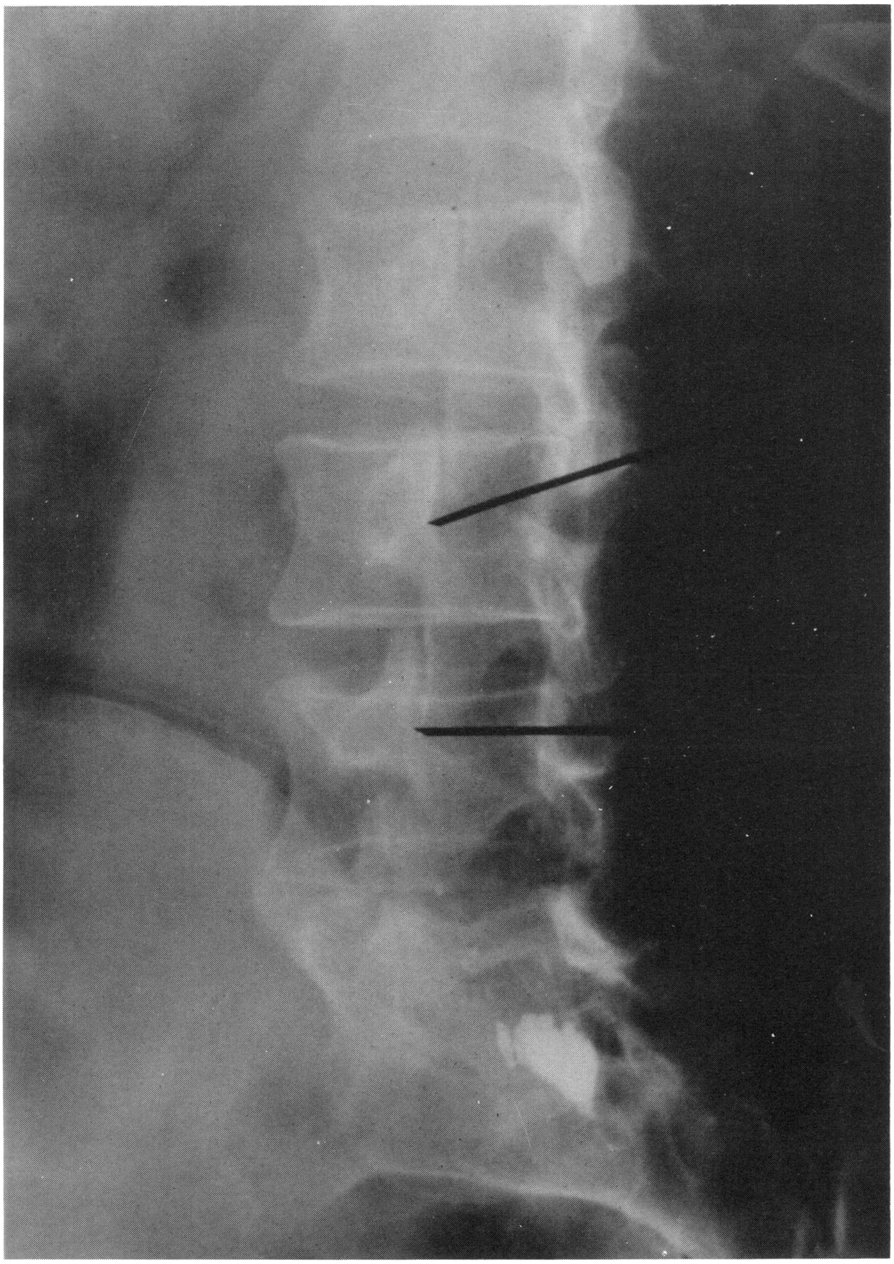

Fig. 7. Positioning of facet rhizotomy needles, oblique view.

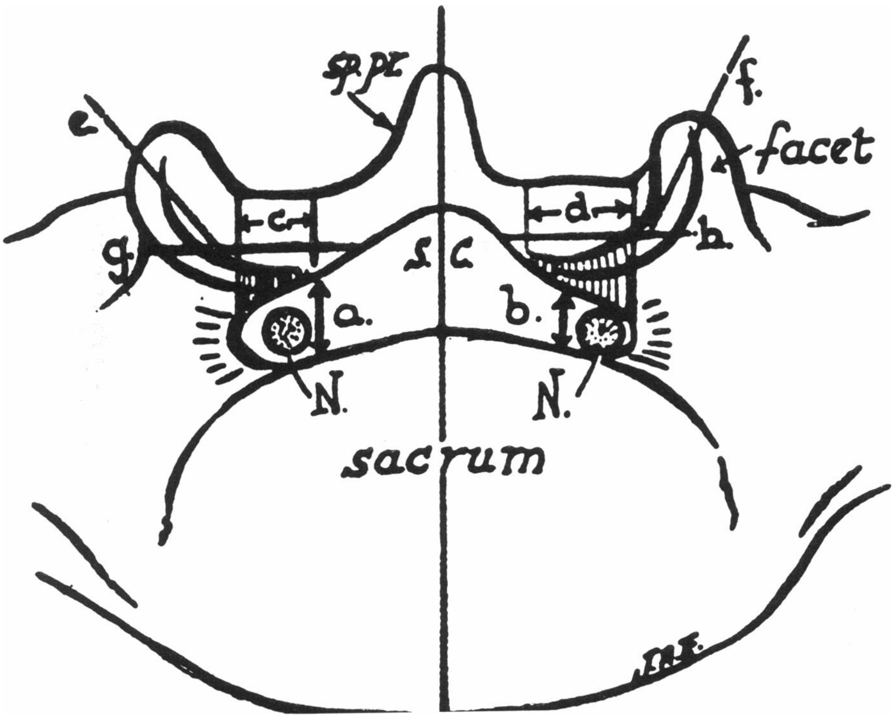

Fig. 8. Cross-section of the canal at the level of the superior sacral facets; impingement was caused by facet with increasingly frontal orientation. a = normal lateral recess depth, b = lateral recess depth compromised by facet, c = frontally oriented portion of facet, d = large amount of frontally oriented facet, e and g = localize the recess forming portion of the facet, f and h = localize the dimension of the offending facet's overhang, N = nerve root, SC = spinal canal, Sp.pr. = spinous process. Modified and reproduced by permission from Epstein, J., Epstein, B., Rosenthal, A., Carras, R., and Lavine, L.: Sciatica caused by nerve root entrapment in the lateral recess: The superior facet syndrome. *J. Neurosurg. 36*:588, 1972.

levels for each facet joint involved. Figures 6 and 7 demonstrate the positioning of the needles. The procedure is only mildly painful; a great majority of patients, 90% or more, have had immediate relief of back and leg pain within 24 to 48 hours. In our series, 50% of patients experienced lasting relief with good or satisfactory results for up to three months. A smaller percentage gained satisfactory relief only upon repetition of the procedure. By six months, however, the rate of satisfactory results has dropped to approximately 33%. There are two possible explanations. First, the lesions might have been placed inexactly,

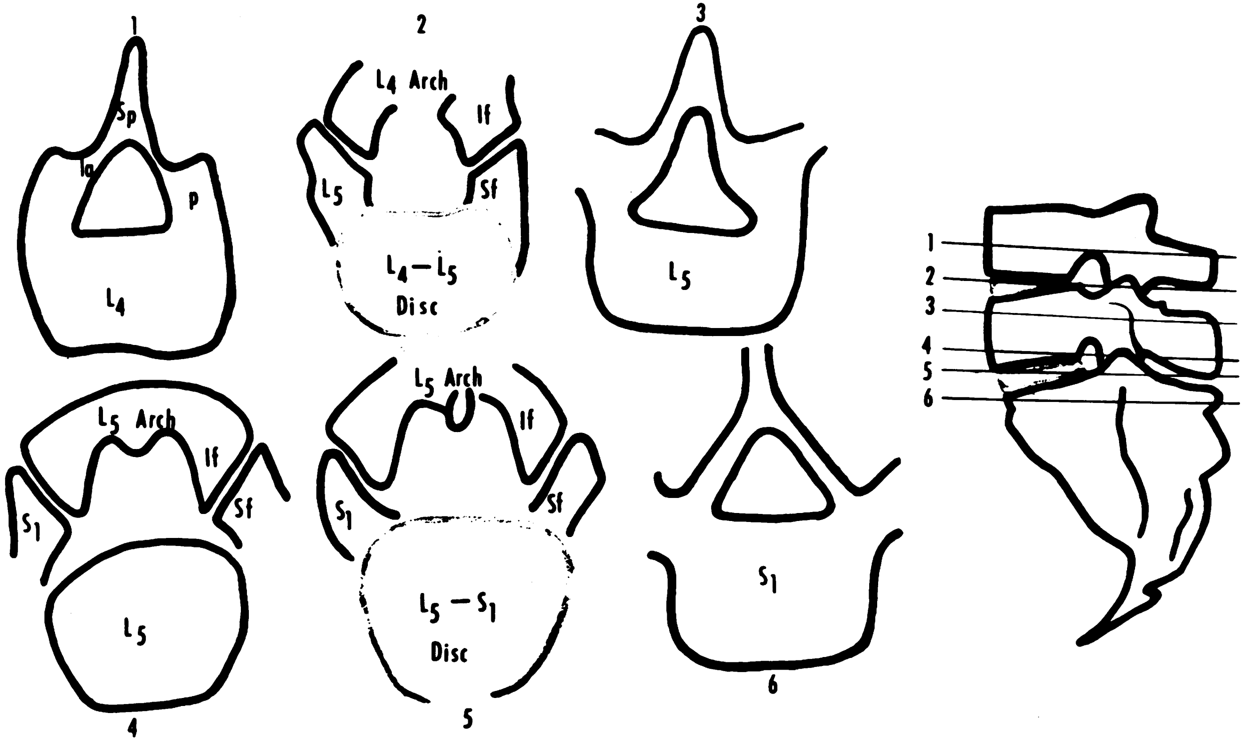

Fig. 9. Cuts taken in transaxial tomography and sections visualized. Sp = spinous process, If = inferior facet. Reproduced by permission from Rothman, R. and Simeone, F.: *The Spine*. Philadelphia, Saunders, 1974, p. 470.

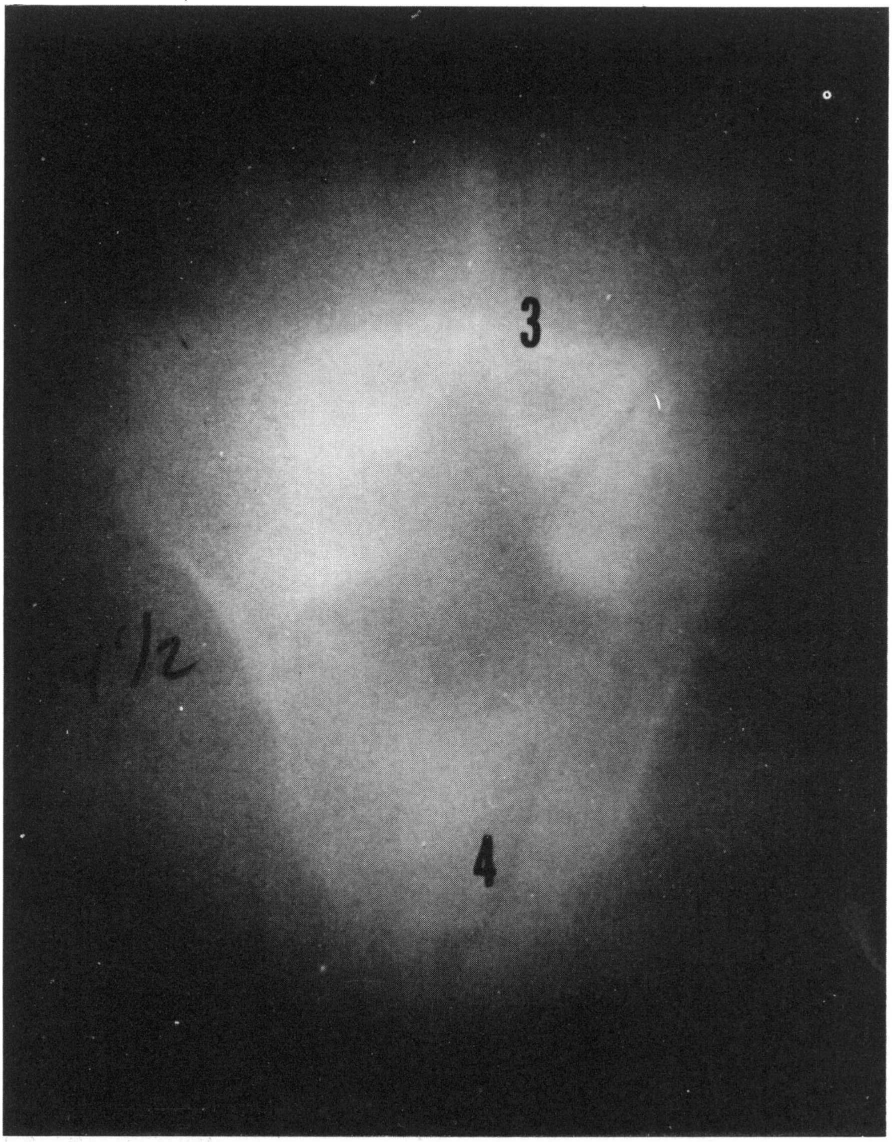

Fig. 10. Transverse cut taken at L3-L4; tomogram shows lateral recess well.

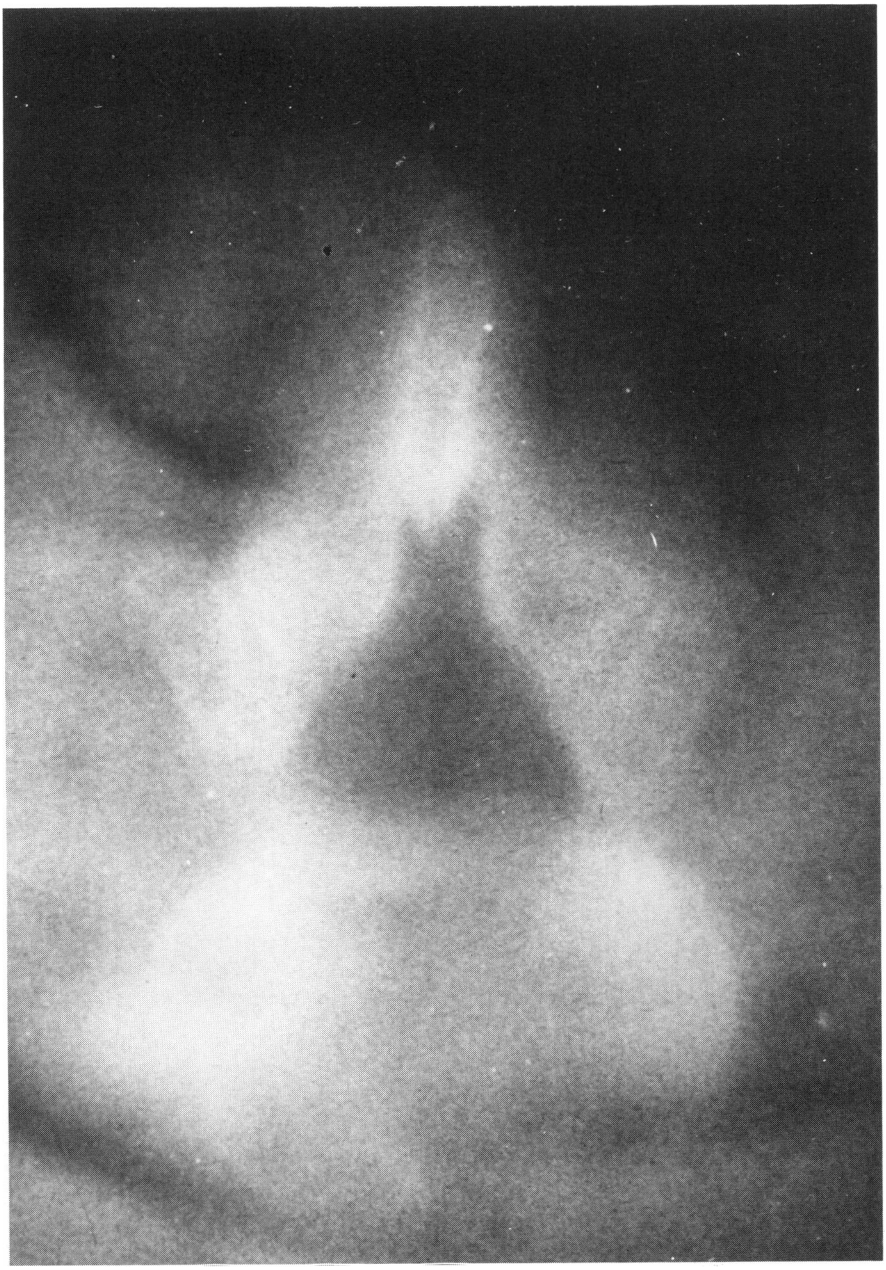

Fig. 11. Cut taken at L5-S1; tomogram shows no evidence of disease in the facet.

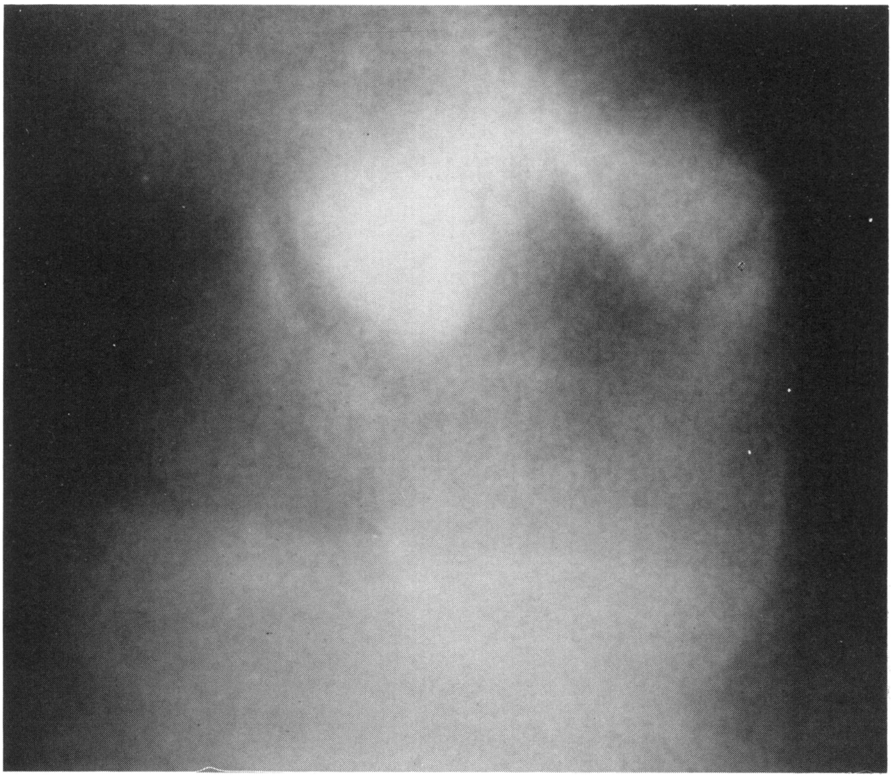

Fig. 12. Tomogram of sclerotic facet shows impingement into recess.

i.e., they did not adequately lyse the dorsal ramus. The second possibility, which needs to be investigated, is that the facet is reinnervated either through regeneration or via a cross-over from another segment.

Another problem related to the facet joint which we should like to discuss is the so-called syndrome of the lateral recess or the superior-facet-encroachment syndrome. This problem is yet to be appreciated fully by the clinical community, although it was described clearly by Schlesinger and others as long as 20 years ago.[6]

As mentioned earlier, as one descends caudad in the lumbar spine the orientation of the articular processes is increasingly frontal. The superior facet extends for a variable distance toward the midline and therefore forms the posterior wall of a recess, called the lateral recess, which has as its anterior wall the disc and the body of the next cephalad vertebra. There is great variability in the depth of this recess and entrapment of the nerve root in the recess has been shown clearly to be a cause of sciatica (see Figure 8). A serious problem for clinicians is that both routine roentgen examination of the spine and myelograms may fail to reveal this condition.

We should like to mention briefly, therefore, the invention of a new technique, transaxial tomography,[7] which has particular relevance to the diagnosis of facetal impingement disease. Basically, it provides a cross-section of the spine; serial sections are obtained in any one examination. Figure 9 demonstrates the tomographic cuts taken and the various views of the spine obtained. The special value of the new technique is that it can display the canal and the lateral recess, particularly at the interbody segment where the trouble often lies; it can do this noninvasively. Total radiation exposure during any one examination is comparable to that in a lumbar myelogram. The tomograms shown in Figures 10 and 11 show no disease. Comparison should be made with Figure 12, which clearly shows facetal disease and impingement. The transaxial tomographic technique is in its developmental stages, but we predict that it will supplement myelography as the definitive procedure in the study of low-back pain.

The diagnosis of the facetal impingement syndrome often rests on awareness of the entity. An electromyogram is usually helpful. The surgical cure is liberal decompression of the lateral recess.

To sum up, the posterior articulating joints of the lumbar spine must be remembered as a key element in the pathology of low-back-pain syndromes and in sciatica. Certainly the future holds many challenges for us. We need improved diagnostic aids such as transaxial tomography keyed toward understanding of the dorsal articulations; we must work out the diagnostic and prognostic importance of asymmetry in the lumbar facets. Facet rhizotomy may prove useful in some pain syndromes. The facet joints and their pathological findings demand more of our attention, and these findings must be related to the total pattern of degeneration in the lumbar spine. Only in this way shall we find the means to forestall the spinal disabilities which have threatened each of us since the day he first stood erect.

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